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MAR 1 1994

MAIL BRANCH

William F. Caton
Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

February 28, 1994

Re: **MM Docket No. 93-177**

Dear Mr. Caton:

Transmitted herewith for filing are 1 original and 4 copies of **Reply Comments of Milstar Broadcasting Corp.** in connection with the above referenced proceeding (RM-7594).

If there are any problems or questions, please contact me; and, thanks.

Cordially,

Barry Skidelsky

Barry Skidelsky

BdS:hp
att.

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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MAR 1 1994
MAIL BRANCH

In the Matter of

An Inquiry into the Commission's Policies and Rules regarding AM Radio Service Directional Antenna Performance Verification	))))	MM Docket No. 93-177 RM-7594

REPLY COMMENTS OF MILSTAR BROADCASTING CORP.

Milstar Broadcasting Corp. ("Milstar"), Commission licensee of WXCT (AM) in Hamden, Connecticut, by counsel, hereby submits its Reply Comments in response to the Notice of Inquiry ("NOI") released June 29, 1993, in connection with the above referenced proceeding, as follows.

Milstar concurs with the goals set forth in paragraph 8 of the NOI, wherein the Commission states a desire "to formulate a set of proposed rules which will ensure that array evaluations are done thoroughly and accurately, and to the degree necessary to meet the interference criteria put in place as a result of MM Docket No. 87-267."

In paragraph 7 of the NOI, the Commission states that: "In its broadest sense, this inquiry seeks to identify those portions of the current rules affecting AM directional arrays which ought to be the subject of a Notice of Proposed Rule-Making."

Current FCC rules and policies affecting AM directional arrays are based on the use of traditional vertical radiators, where each radiator is excited or directly fed power from a transmitter through a transmission line and network of coils and capacitors.

However, current technology provides reliable alternatives to the traditional model; and, the public interest dictates that greater flexibility should be available to broadcasters in the construction and use of directional arrays.

In particular, Milstar urges that AM broadcasters be permitted to use alternative directional arrays as set forth in the engineering statement attached hereto and made a part hereof.

Respectfully,

MILSTAR BROADCASTING CORP.

by Barry Skidelsky, Esq.
655 Madison Avenue
19th floor
New York, NY 10021

February 28, 1994

ENGINEERING STATEMENT
PREPARED ON BEHALF OF
MILSTAR BROADCASTING CORP.
IN SUPPORT OF
REPLY COMMENTS IN MM DOCKET NO. 93-177, RM-7594

In the Matter of

An Inquiry into the Commission's Policies and Rules regarding AM Radio Service Directional Antenna Performance Verification

SUMMARY

The following engineering statement has been prepared on behalf of Milstar Broadcasting Corp. ("Milstar"), licensee of AM station WXCT, Hamden, Connecticut. As a broadcast licensee, owner of a directional antenna facility on 1220 kHz and applicant for improved facilities, Milstar has a strong interest in the above noted Notice of Inquiry ("NOI"). In its Reply Comments, Milstar wishes to focus on the types of antennas which can be employed at standard broadcast stations. Milstar's recommendations are summarized as follows:

1. The Commission should allow the use of <u>parasitic arrays</u> where the pattern shape is obtained by the proper placement and adjustment of vertical radiators near a single vertical radiator which receives all of the transmitter power. (See Comments of Radiotechniques Engineering Corp., pp 4 "Passively driven elements of an antenna system are technically practical, but not permitted under current policies".)

2. The Commission should allow the use of curved or <u>slanted radiators</u> designed to optimize nighttime radiation patterns or to take advantage of sites with limited available area for the construction of a directional antenna system. (See Comments of Radiotechniques Engineering Corp., pp 4, "Antenna Structures can be optimized in their structural configuration for improved night performance, but the present Rules do not consider this factor (curved and slanted radiators)."

PARASITIC ARRAY BACKGROUND

Parasitic arrays are antenna systems where one tower is fed and the remaining towers shape the antenna pattern by virtue of their height and physical relationship to the tower being fed. They have been in use for decades. George H. Brown wrote about parasitic arrays in the Proceedings of the Institute of Radio Engineers ("IRE"), Vol. 25, No. 1, January 1937. Brown described the design of single parasitic reflector arrays at great length in this article. ***Figure 1***, attached, is a copy of the computed directional antenna patterns found in the IRE article. In the conclusion of his paper, Brown stated:

> "In the preceding discussion, we have treated the cases of both driven and parasitic arrays. Where possible, the results have been tested by comparison with experimental results.
>
> The field and circuit conditions are treated for the case of multi-element driven arrays. For a given current ratio and phase relation, the effective impedance of each antenna and the total radiated power, as well as the power radiated by each antenna, are readily found. The radiation pattern of the array is easily calculated. These arrays are often used to protect the service areas of other stations operating on the same frequency.
>
> In the case of a single parasitic reflector, it is found that the mysterious something that is supposed to happen when the spacing is one-quarter wave length fails to materialize. Closer spacings are found to be desirable in both the transmitting and receiving case. It is found that the parasitic antenna functions equally well as a director or a reflector."

Today, parasitic arrays are built and used on a regular basis in all parts of the world including Canada, Mexico and the Caribbean. Just one example is CHUC, 1450 kHz, Cobourg, Ontario, Canada which uses a three tower array employing parasitic elements.

Although current FCC Rules do not specifically prohibit parasitic radiators, the practice of the AM Branch of the Mass Media Bureau is, and has been, not to allow the use of parasitic arrays. Milstar requests that this policy be modified to allow parasitic arrays.

It is believed that parasitic arrays have historically not been encouraged by the AM Branch due to the fact that there is little ability to adjust the pattern shape once the array is built, an inherent characteristic of this antenna type. However, as the Commission notes in paragraph 5 of the NPRM, "Several sophisticated antenna array modeling programs are now available for use on computers which can predict patterns for very complex combinations of power and phase." These programs are based on the Numerical Electromagnetics Code, Method of Moments, and do, in fact, allow very accurate prediction of parasitic array operating characteristics and performance when variable reactances are placed across the parasitic elements tower base to ground. The use of a variable reactance to ground at the base of a parasitic element provides control of the radiation pattern to the extent necessary that construction permit limitations may be met. Thus, the FCC's historical aversion to parasitic arrays need not continue, and the use of parasitic arrays should be permitted.

SLANT WIRE RADIATORS

Another alternative to the traditional model may be found in slant wire radiators, such as described by Grant W. Bingeman, of Continental Electronics/Varian, in his paper presented at the 41st Annual Broadcast Engineering Conference Proceedings, NAB, 1987, entitled "An Economical Directional Antenna For AM Stations". A copy of a portion of this paper is attached as Appendix 1 to Milstar's Comments. Bingeman described a parasitic directional antenna made up of a vertical guyed tower and one guy wire configured as the parasitic element. In practice, a sloping radiator can be a cable attached to a tower with its length and orientation set to satisfy a specific protection requirement. The slanting wire can be fed as in a traditional directional array or used as a parasitic element with pattern shape adjustments being made with a variable reactance between the sloping wire and ground as would be the case for a parasitic array. The use of slant wire arrays should also be permitted.

BENEFITS TO THE PUBLIC AND BROADCAST COMMUNITY

Milstar believes that the public and broadcast community would benefit should the Commission allow the use of parasitic arrays and slant wire antennas:

1. Parasitic arrays and slant wire antennas are less expensive to build and maintain than fed arrays, in part because feedlines and power distribution and phasing circuitry are

not required. In addition, zoning, site or land use restrictions may be of lesser impact.

2. Furthermore, slant wire arrays offer particular advantages in a number of situations:

   A. They give an existing broadcaster with a single nondirectional tower the ability to add a modest directional antenna pattern. This would be particularly beneficial for stations wishing to gain added nighttime service, who have one deep nighttime protection requirement.

   B. Stations wishing to move to the Expanded Band could employ a sloping radiator on their existing tower with a diplexer. This would minimize the expense of the diplexer circuitry and allow for the implementation of a simple directional antenna pattern in the expanded band if desired.

FCC RULE CHANGES, INTERNATIONAL CONSIDERATIONS

The FCC Rules, Part 73, have been reviewed to determine what changes, if any, would be required to allow the use of parasitic arrays and slant wire antennas. It is Milstar's belief that no changes to the Rules are required for parasitic arrays. The FCC's computer Routine "Radiat" already supports the use of parasitic arrays and reflects the formulas found in Section 73.150 of the Commission's Rules. Nonetheless, an express recognition of their permitted use is in the public interest.

Slant wire radiators would require modification to the formulas found in Section 73.150 to account for the sloping characteristic of the radiator. A recently discovered paper by Harry Fine, Federal Communications Commission office of the Chief Engineer, Technical Research Division, T.R.R. Report No. 1.2.5 entitled "Radiation From Grounded Slant Antennas" includes some recommended simplifying assumptions which may become the basis of a Petition for Rulemaking planned to be filed by Milstar requesting a change in Section 73.150 to allow slant wire radiators.

CONCLUSION

Milstar believes that it is important to consider parasitic arrays and slant wire radiators as part of this Notice of Inquiry. Failure to look at the broadest spectrum of radiator types disserves the public interest and could cause the Commission to implement revised Rules which do not give broadcasters the full flexibility necessary to deal with today's zoning and land use restrictions. Broadcasters should have the ability to construct and use these antenna systems. Milstar believes that the slant wire antenna is particularly important because it would allow a broadcaster to implement simple directional antenna patterns without the need for new tower construction or property additions.

The foregoing was prepared on behalf of **Milstar Broadcasting Corp.** by Clarence M. Beverage of *Communications Technologies, Inc.*, Marlton, New Jersey, whose qualifications are a matter of record with the Federal Communications Commission. The statements herein are true and correct of his own knowledge, except such statements made on information and belief, and as to these statements he believes them to be true and correct.

By ______________________

Clarence M. Beverage
for Communications Technologies, Inc.
Marlton, New Jersey

SUBSCRIBED AND SWORN TO before me,

this 28th day of February, 1994,

Esther G. Sperbeck, NOTARY PUBLIC

ESTHER G. SPERBECK
NOTARY PUBLIC OF NEW JERSEY
MY COMMISSION EXPIRES OCT 15, 1997

AN ECONOMICAL DIRECTIONAL ANTENNA FOR AM STATIONS

GRANT W. BINGEMAN

CONTINENTAL ELECTRONICS / VARIAN

An existing non-directional broadcast site can be modified to produce a directional gain of three dB, equivalent to doubling transmitter power in the direction of maximum gain, without adding another tower. This is accomplished by using one of the guy wires as a parasitic element. All insulators on the selected top-level guy are shorted except the top and bottom ones. This guy wire can then be tuned at its base.

If the tower is near 90 degrees in height, the guy requires a capacitive tuning reactance for both reflector and director performance. More capacitive reactance is required to produce a director. When the guy is tuned as a director, driver resistance is lower, and bandwidth is narrower. Thus best overall results are usually obtained by tuning the guy as a reflector when the full length of the guy wire is in circuit.

Ordinarily one might expect the reflector to require an inductive reactance at its base, since an inductor makes a wire look longer, and a capacitor makes a wire look shorter. Normally a reflector is physically longer than the driven element, and a director is shorter. Keep in mind that a guy wire is typically 12 to 15 percent longer than its tower projection. Thus a full-length top-level guy wire on a quarter-wave tower may behave as a reflector when shorted at its base, depending on how much of the tower top is cantilevered. If the tower were only 70 degrees tall, then an inductive reactance would indeed be required to make one of its top-level guys perform as a reflector.

This raises the possibility of tuning the guy by adjusting its active length. That is, why not short the bottom guy insulator to ground, then short just enough of the upper insulators to produce the desired pattern? This eliminates the need for a tuning reactance alltogether. Figure 1 shows two of the many patterns which can be obtained in this way when the tower is a quarter wave tall. Bandwidth is also best when no tuning reactance is used.

It may sometimes be convenient to drive the guy-wire, and tune the tower. Since the tower is not as long as the guy, it requires somewhat less capacitive tuning reactance at its base. Comparing Figures 2 and 3, where identical tower and guy dimensions are used, one can see that similar gains are obtainable. However, the input impedance of the driven tower case (Figure 3) is about half that of the driven guy case (Figure 2). This is not too important, as the bandwidths of the two configurations are comparable. However, one case may be easier to match to the transmission line impedance. As expected with this close element spacing, bandwidth is rather narrow compared to a non-directional tower alone (see table of impedances in Figure 3).

Figure 4 compares the vertical patterns of a 250 foot non-directional tower to that of the driven-tower, tuned-guy arrangement of Figure 3. Note the significant increase in high-angle radiation contributed by the parasitic guy wire. This may affect the contours of the night-time fading zone, but that is very dependent on the specific ground conductivity of the area in question.

Allow me to point out that very-high-angle radiation is not likely to be refracted back to earth by the ionosphere, and even if it were, the return signal would be too weak to affect communication in the primary service area. For example, Figure 3 shows a field of 109 mV/m at a mile straight up. The E layer of the ionosphere is about 60 miles up at night, making a round trip of about 120 miles. Even if the straight-up signal were perfectly reflected, the returning signal would be less than one mV/m at the ground.

A horizontally polarized field component exists for elevation angles outside of the tower/guy or the azimuth planes (Figure 5). Note that both the E_ω and the E_θ spherical-coordinate field components are parallel to the azimuth plane when the elevation angle is 90 degrees (straight up). One's sense of up, down, and sideways can become a bit disoriented in a spherical coordinate system where V-pol and H-pol are relative to the observer, not to the azimuth plane.

At any rate, calculation of the fading zone is a relatively straightforward process, and should be part of any application of this hot-guy concept of antenna design.

If desired, tuning can be accomplished with an inductor at the base of the parasitic element, rather than a capacitor, if that element is made short enough. Figure 6 employs 156 feet of hot guy wire, which can be tuned as either a director or a reflector. Note that the transition between director and reflector operation is rapid. From the standpoints of pattern bandwidth and stability, it would be best to tune the parasitic tower to the conservative side of maximum gain, away from the crossover point.

If we define the crossover point between director and reflector operation as the point where equal forward and reverse gains are obtained, some interesting correlations can be observed. Referring to Figure 7, one can see that the relative phase of the tower currents passes through 180 degrees at the crossover point. This is useful knowledge when an antenna monitor is part of the system. Another obvious feature is the peaking of base currents at crossover. This can be a useful tuning aid when an antenna monitor is not available, but an RF ammeter is at hand.

As expected, driving-point impedance changes most rapidly when tuning approaches the crossover point (Figure 8 shows the tower base impedance for the configuration of Figures 6 and 7). Since the tower currents peak at crossover, the base resistance reaches a minimum value. If an impedance bridge is available, crossover can be determined by tuning for minimum feedpoint resistance.

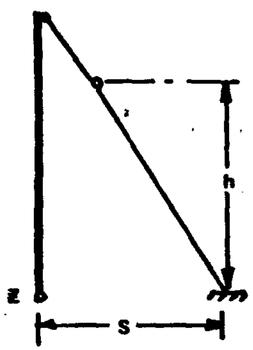
Some special considerations are created when one chooses to use one or more of the guy wires as array elements. First, the voltage stresses across the remaining guy insulators are usually increased, and the voltage gradient on the guy wire is also increased. Of course, the currents in the hot guys are increased. These parameters are easily calculated with general moment-method algorithms, and do need to be taken into account during the design process.

Second, some consideration must be given to improving the ground system near the base of the hot guy wire. Since the guy is acting as a second tower, its ground system should be similar to that of a normal tower. However, in light of the saving in real-estate and tower costs, this is a minor annoyance.

Third, in some installations, the bottom guy insulator may not be very close to the ground. In this case, a drop wire will have to be added if the guy is to be tuned at the base with a reactance.

Although I have not specifically shown any tall tower appplications, there is no reason parasitic guys cannot produce similar results for any height of tower.

All data were obtained using the moment method of antenna analysis.



G = 250'
S = 150'
REFL = 219' ⎫
DIR = 188' ⎭ h

1000 KHz

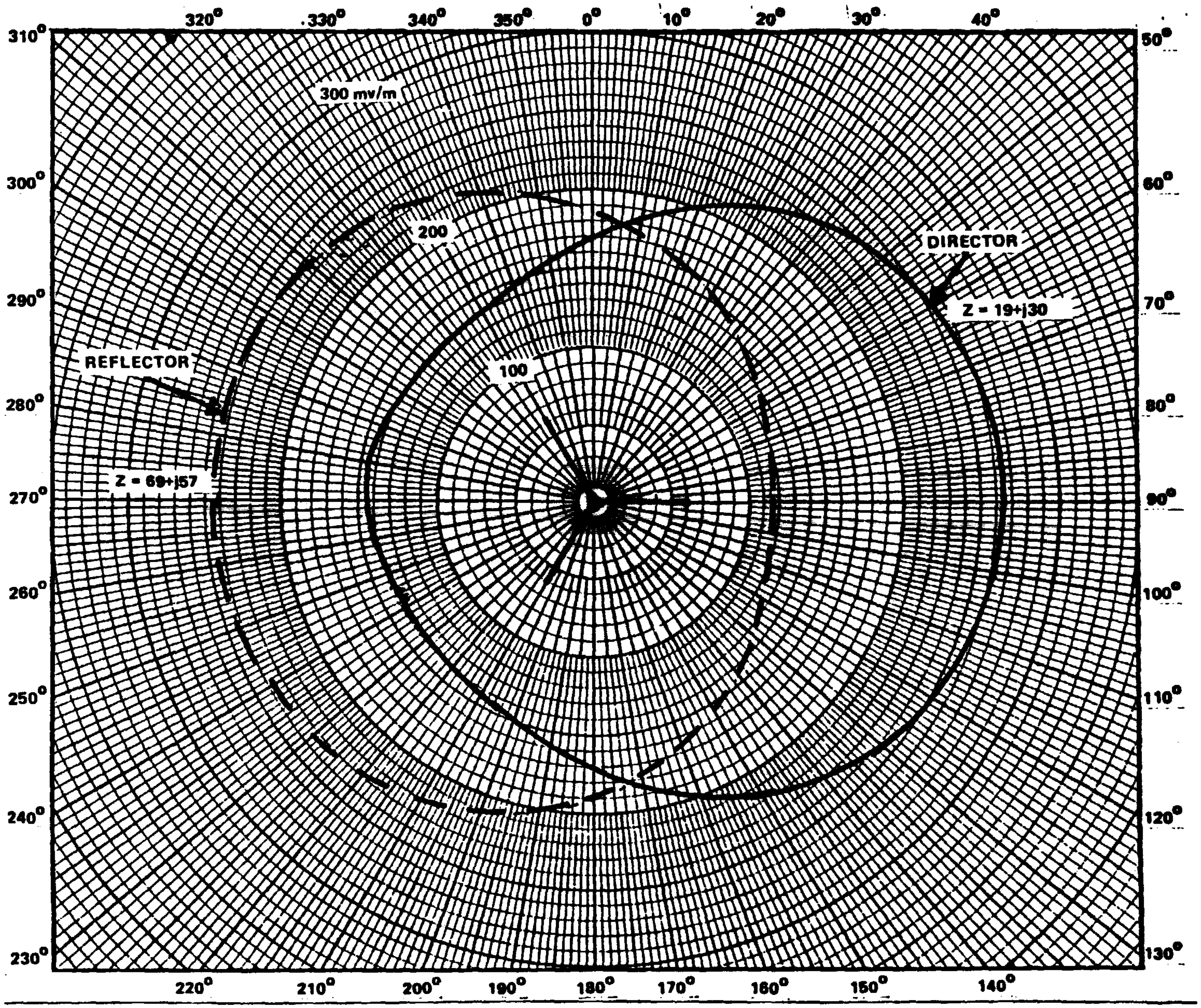


Figure 1 One KW Field At One Mile

21-71(4)

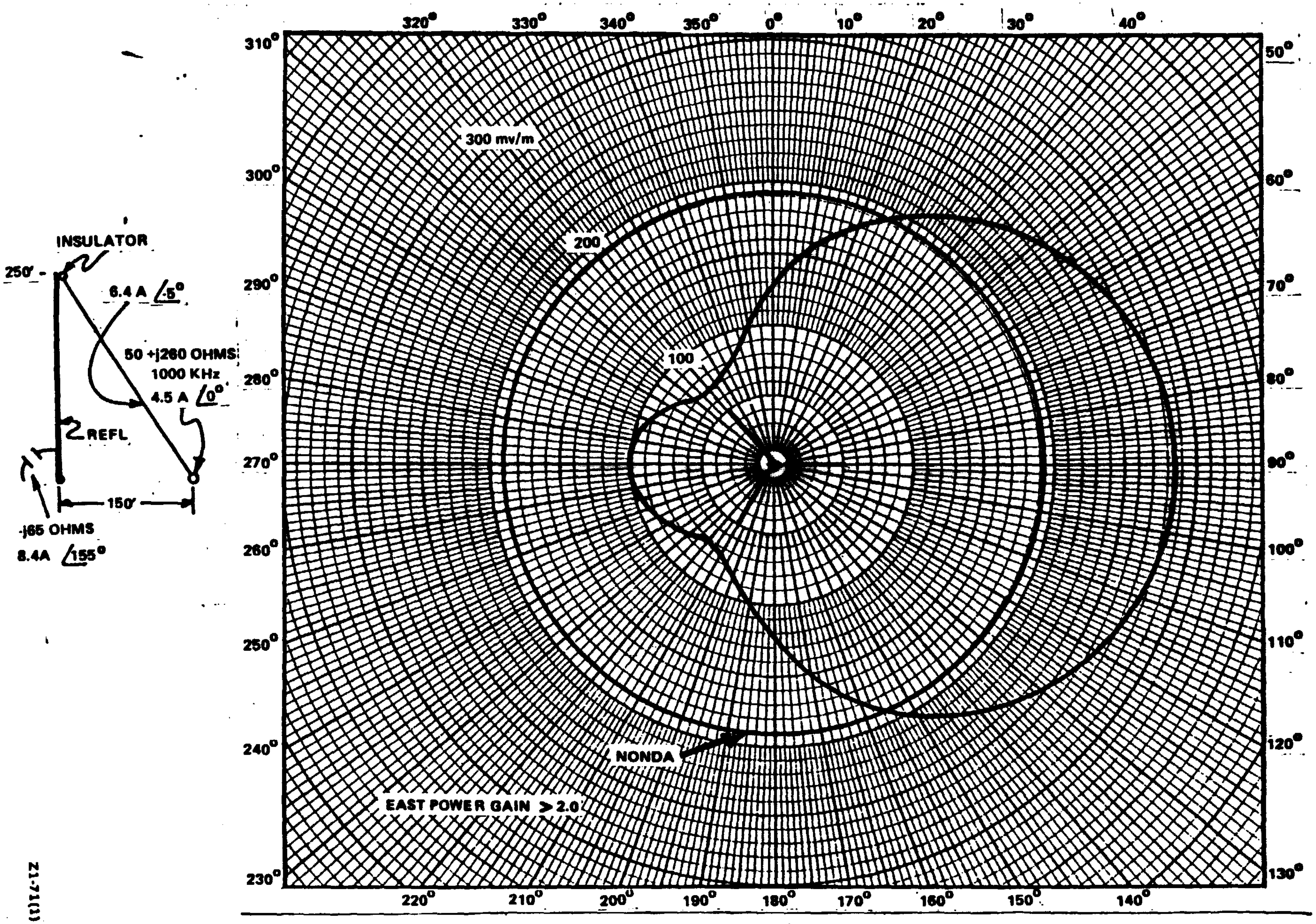
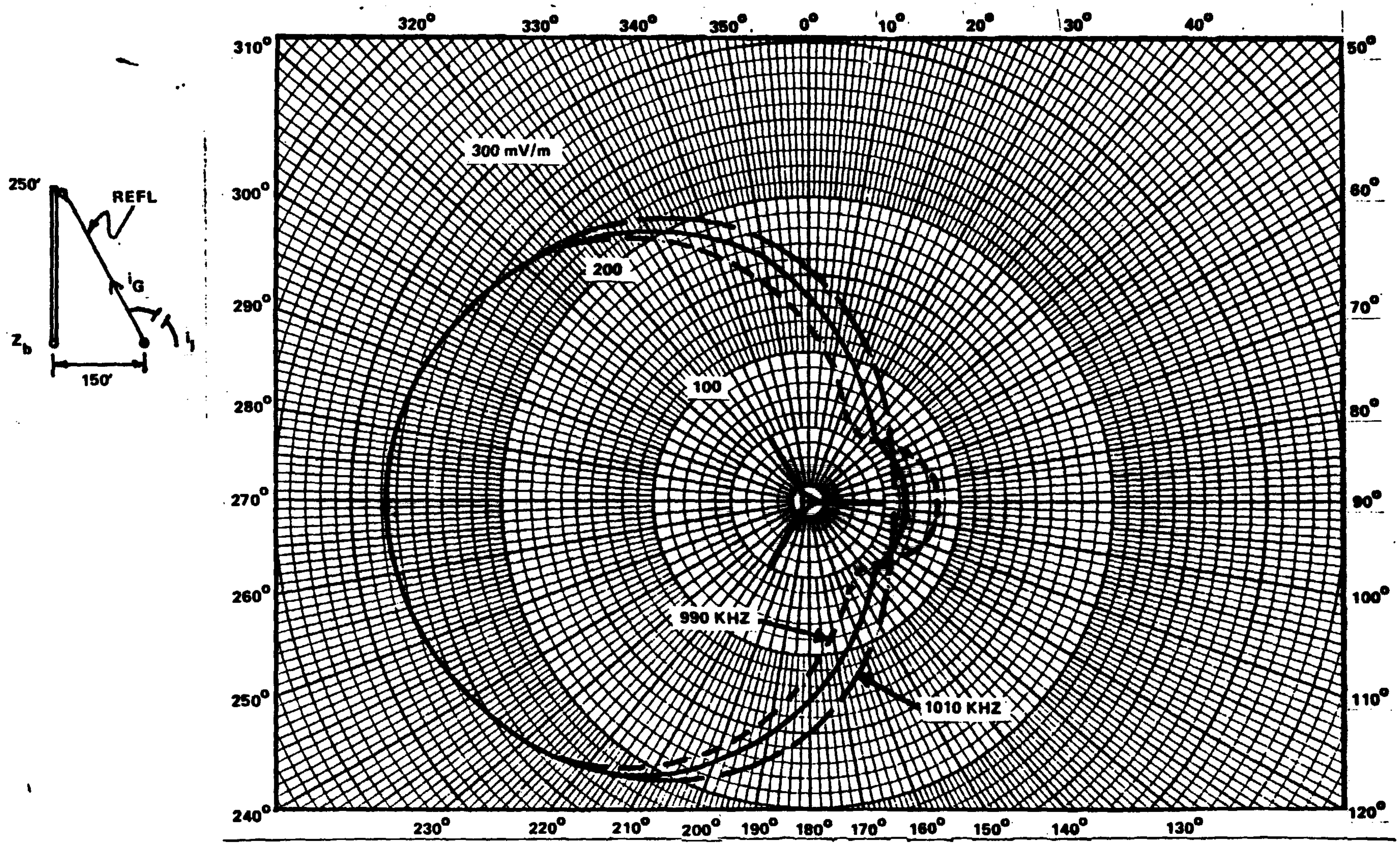


Figure 2. One KW Field At One Mile



KHZ	Z_b	Z_l	i_b	i_l	i_G
990	26.8 +j112.6	0-j161.6	6.1∠0°	6.6∠157°	8.0 ∠157°
1000	37.8 +j125.9	0-j160	5.1∠0°	6.0∠150°	7.3∠150°
1010	54.5 +j137.3	0-j158.4	4.3∠0°	5.3∠140°	6.4 ∠140°

Figure 3 One KW Field At One Mile

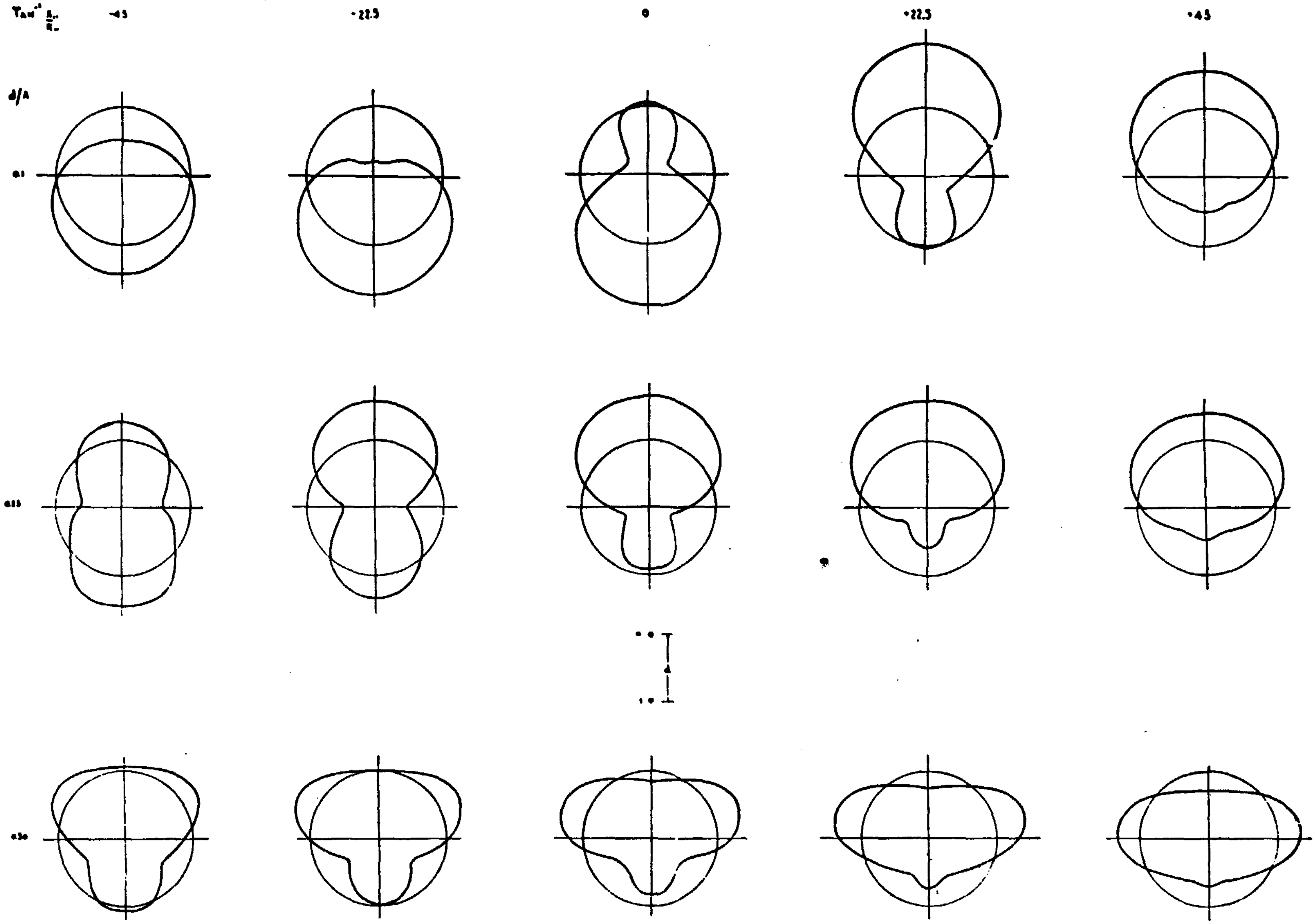


Fig. 28—The horizontal radiation patterns of an antenna and a single reflector, for a number of spacings and tuning conditions.

FIGURE 1

From Proceedings
of the IRE, Vol. 25,
No. 1, January 1937

CERTIFICATE OF SERVICE

I, Esther G. Sperbeck, a secretary in the firm of Communications Technologies, Inc., do hereby certify that I have, this 28th day of February 1994, caused to be mailed by First Class Mail, postage prepaid, copies of the foregoing Reply Comments in MM Docket No. 93-177 to the following:

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